2021 DSCOVR Science Team Meeting

Unique Observational Constraints on the Seasonal and Longitudinal Variability of Earth's Planetary Albedo and Cloud Distribution Inferred from EPIC Measurements

(Part 2)

Andrew Lacis, Barbara Carlson, Gary Russell

NASA Goddard Institute for Space Studies   New York, NY
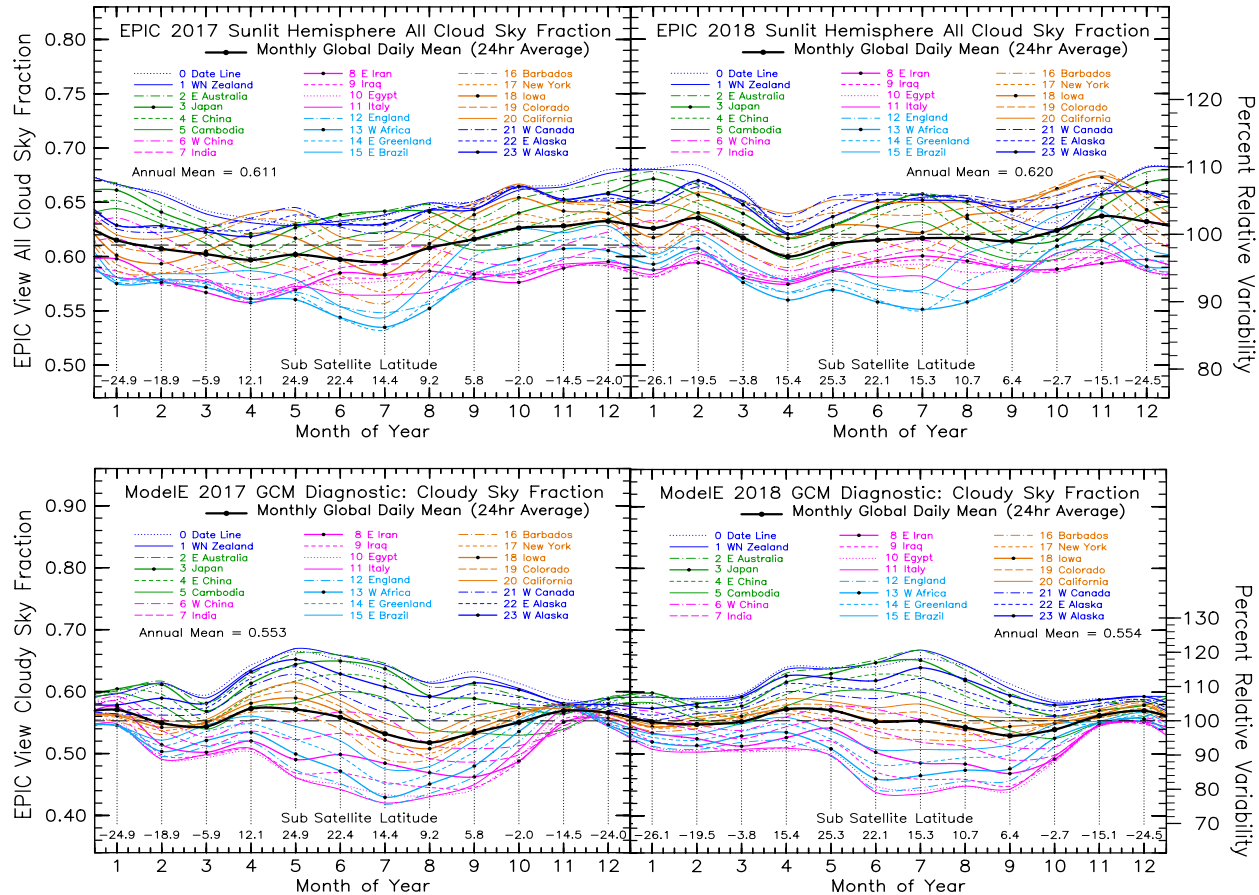
Wenying Su

NASA Langley Research Center   Hampton, VA

NASA Goddard Space Flight Center   Greenbelt, MD
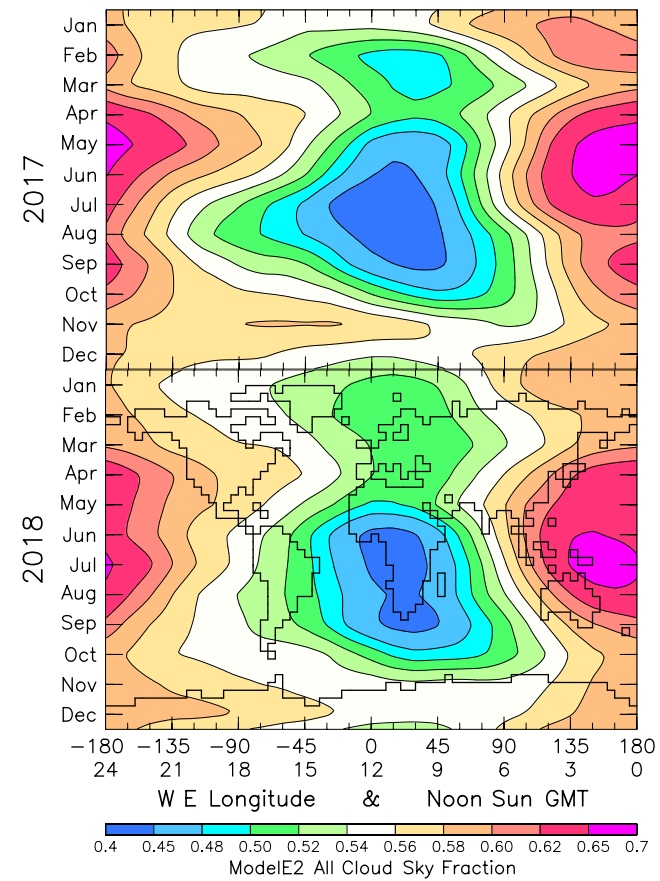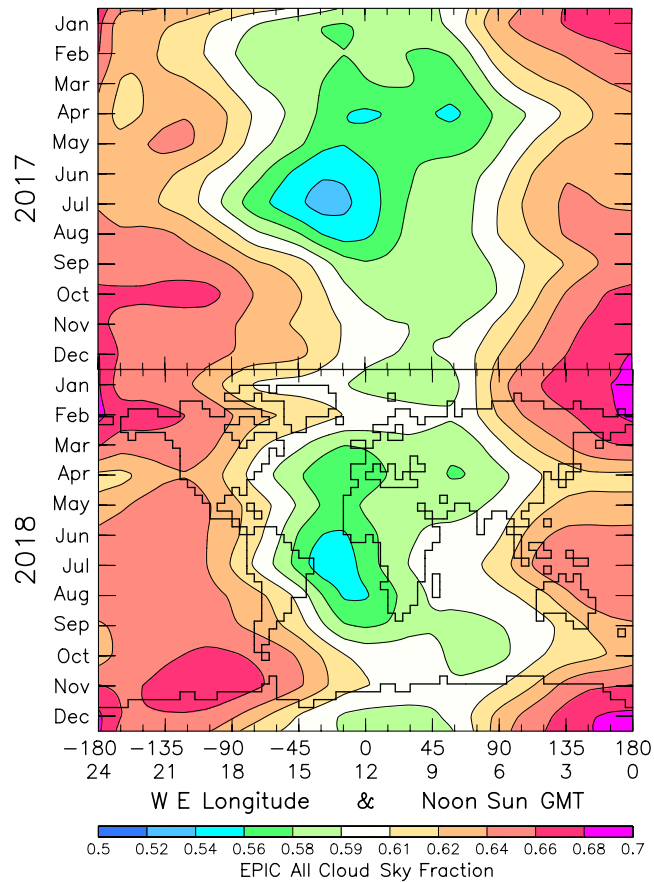September 28 – 30, 2021

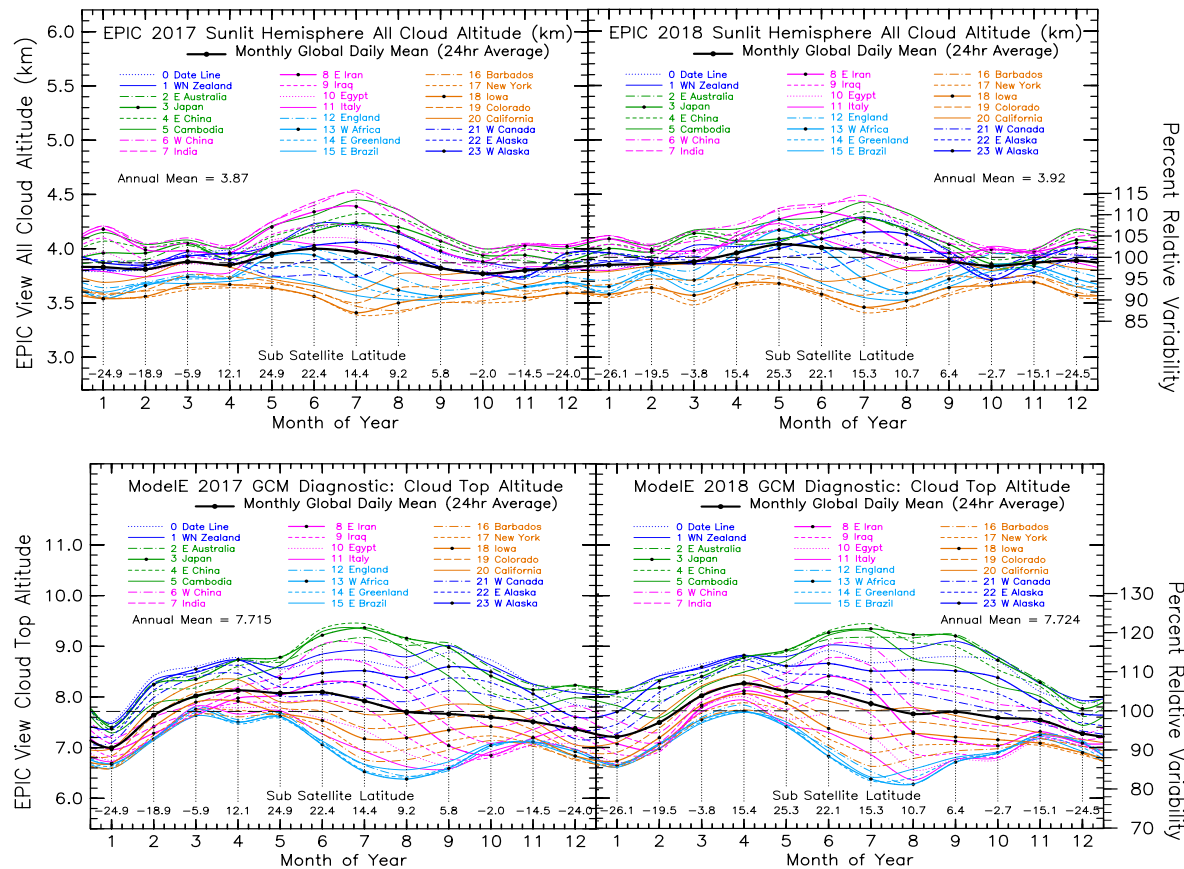# EPIC *vs* ModelE2 All-Cloud Sky Fraction
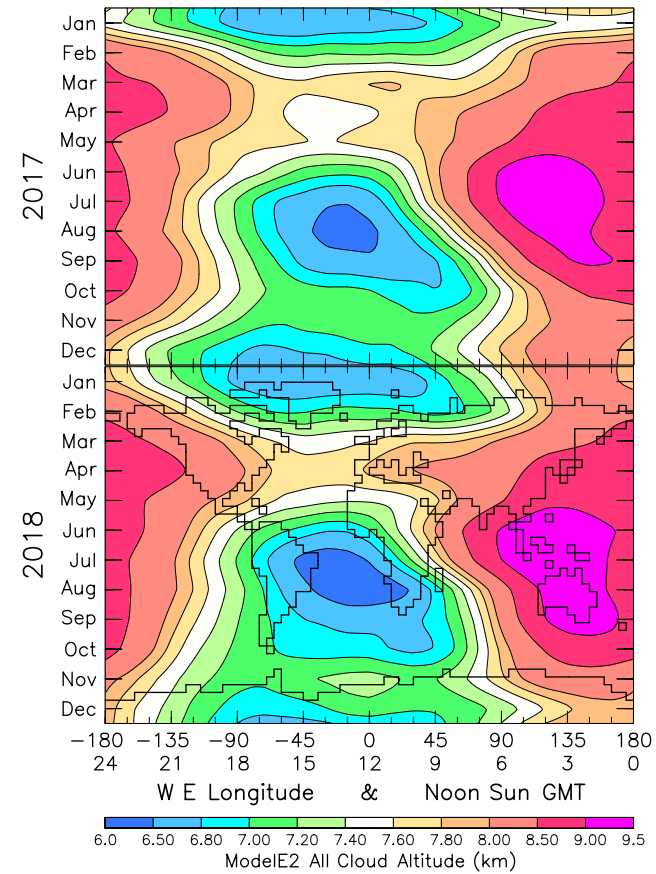
EPIC *vs* ModelE2 All-Cloud Sky Fraction

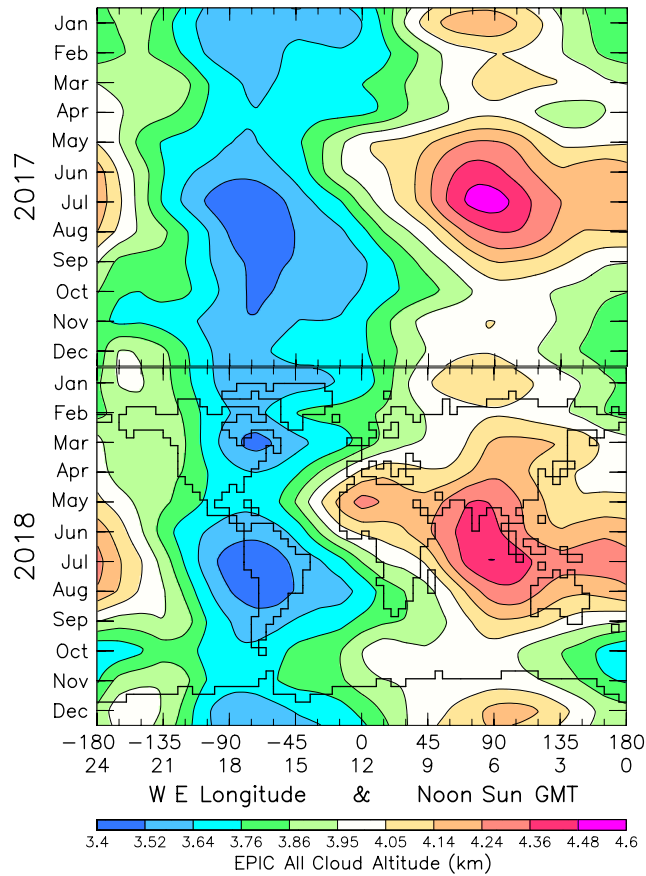# EPIC *vs* ModelE2 Cloud-top Altitude

EPIC *vs* ModelE2 Cloud-top Altitude

EPIC All Cloud Altitude (km)

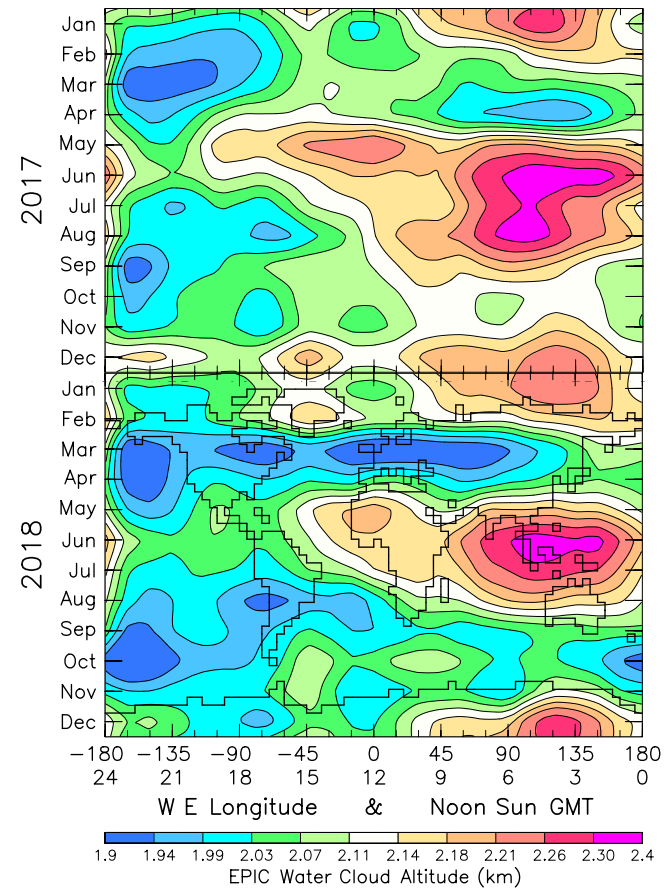ModelE2 All Cloud Altitude (km)

EPIC: Ice-Cloud & Water-Cloud Altitude
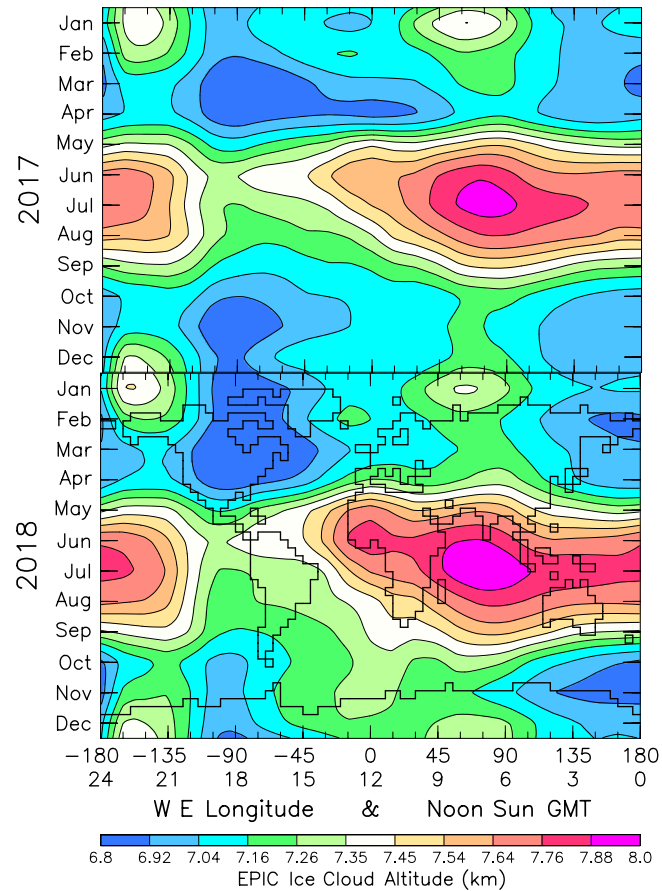
EPIC: Ice-Cloud & Water-Cloud Optical Depth
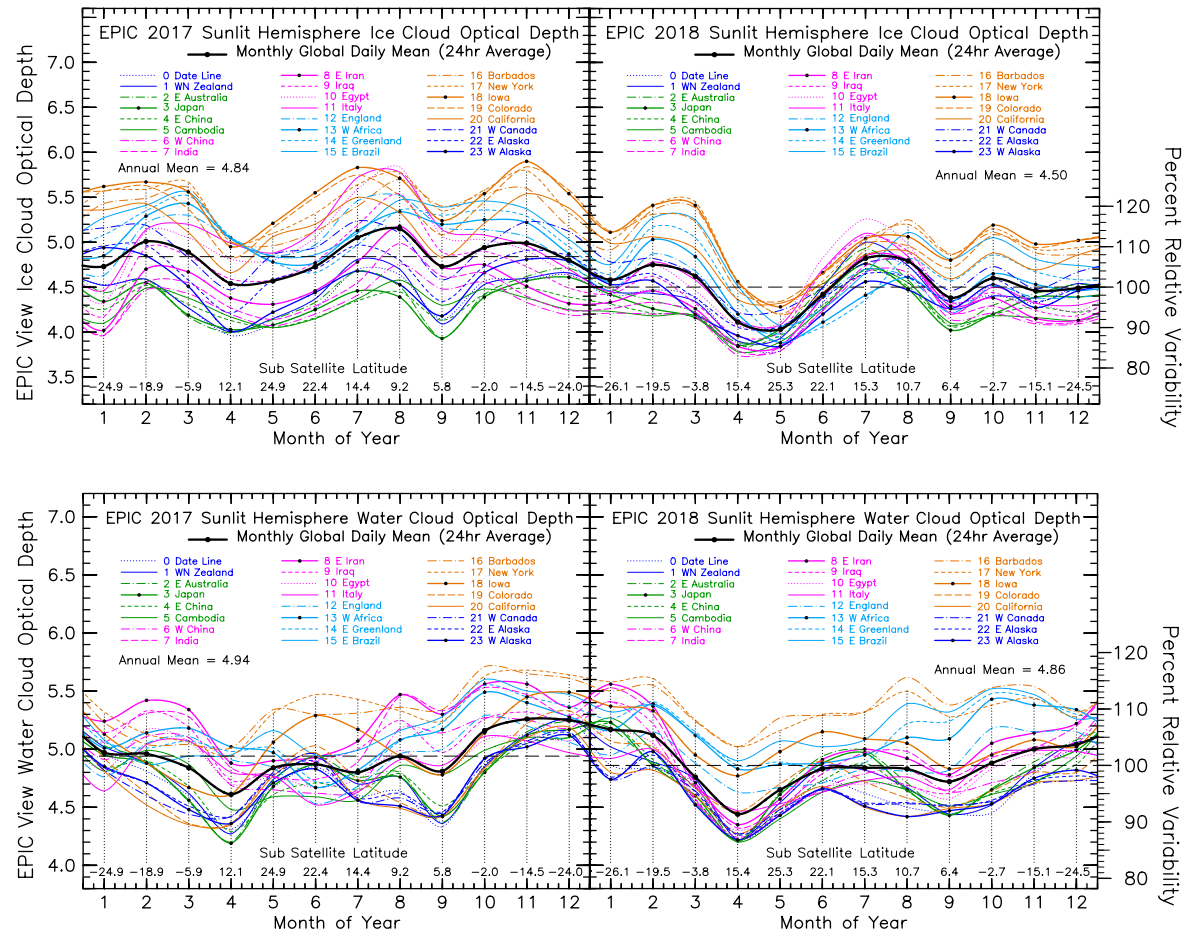
FIGURE 12 | Upper-left: Ice cloud optical depth from EPIC composite analysis results for the year 2017. Upper-right: Ice cloud optical depth for the year 2018.

EPIC: Ice-Cloud & Water-Cloud Optical Depth

EPIC Ice Cloud Optical Depth

EPIC Water Cloud Optical Depth
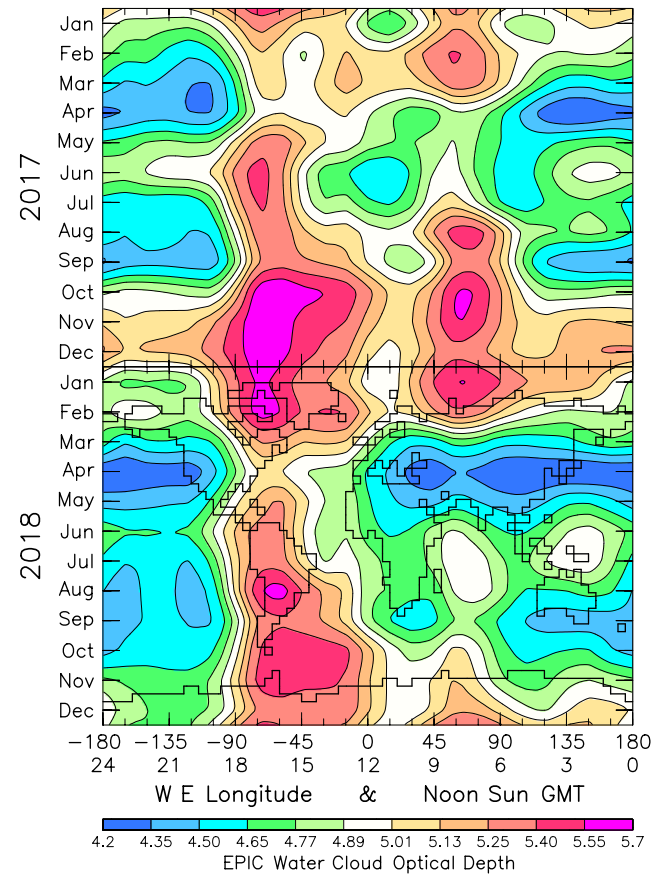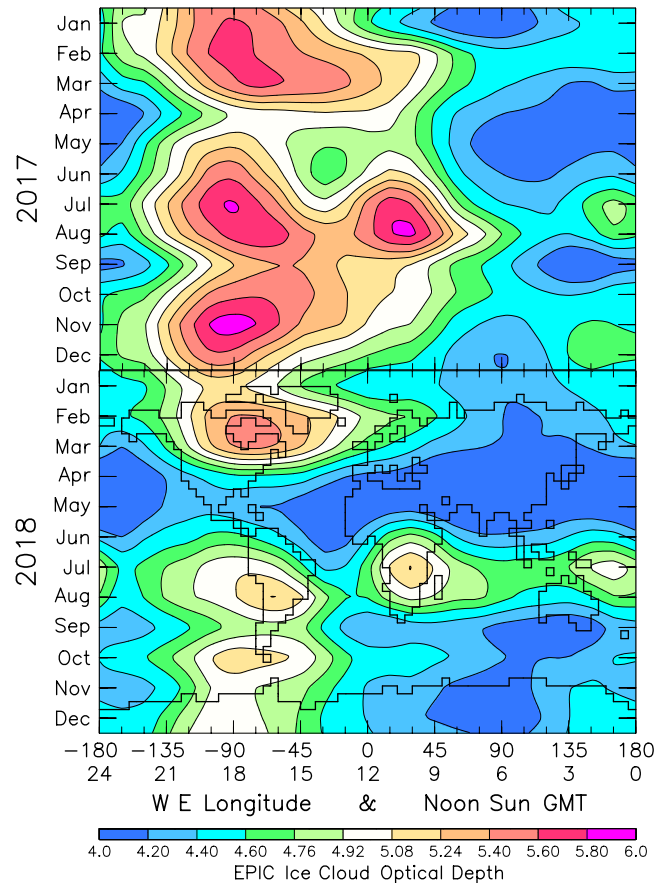
EPIC: Ice-Cloud & Water-Cloud Particle Size
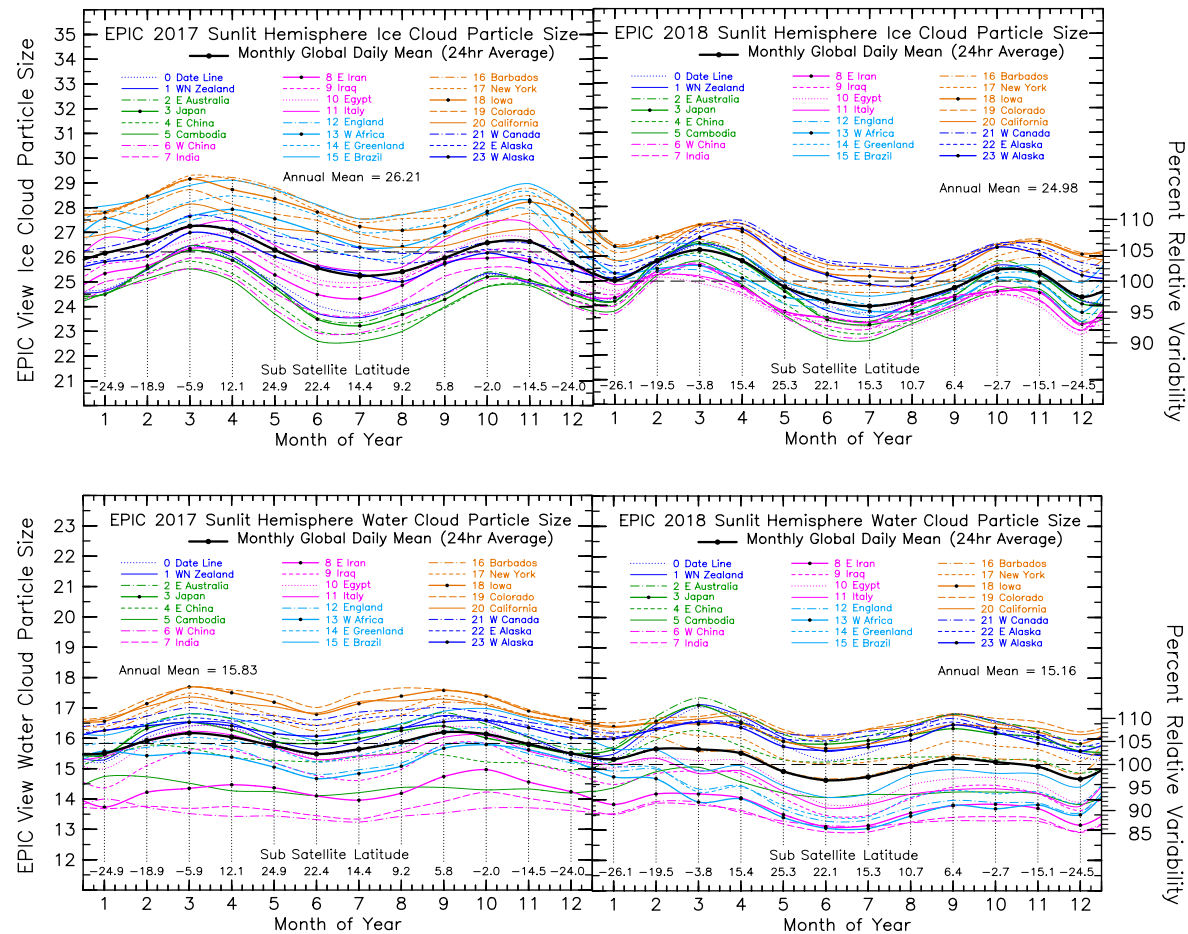
EPIC: Ice-Cloud & Water-Cloud Particle Size
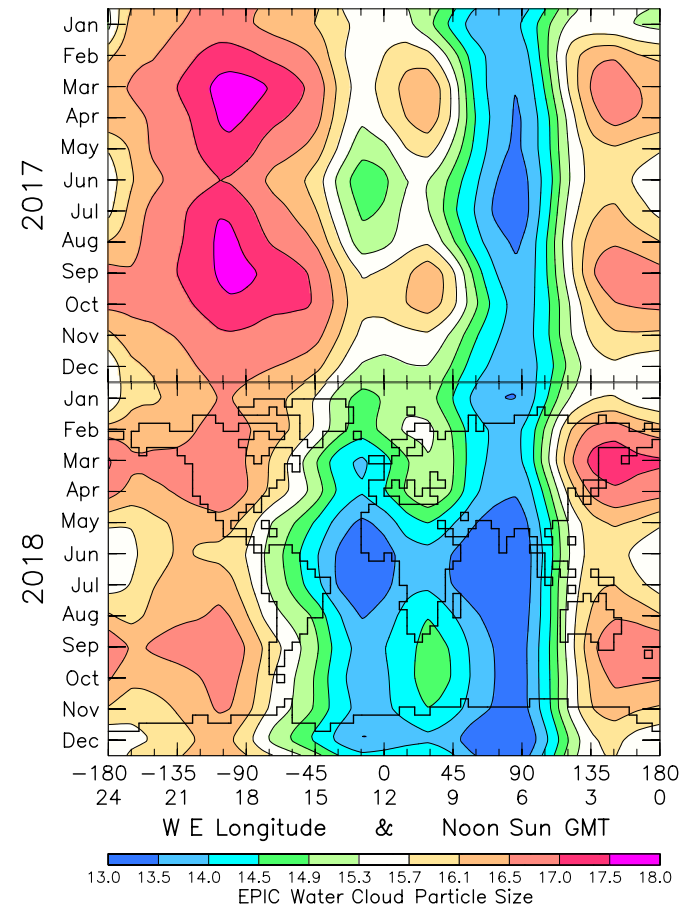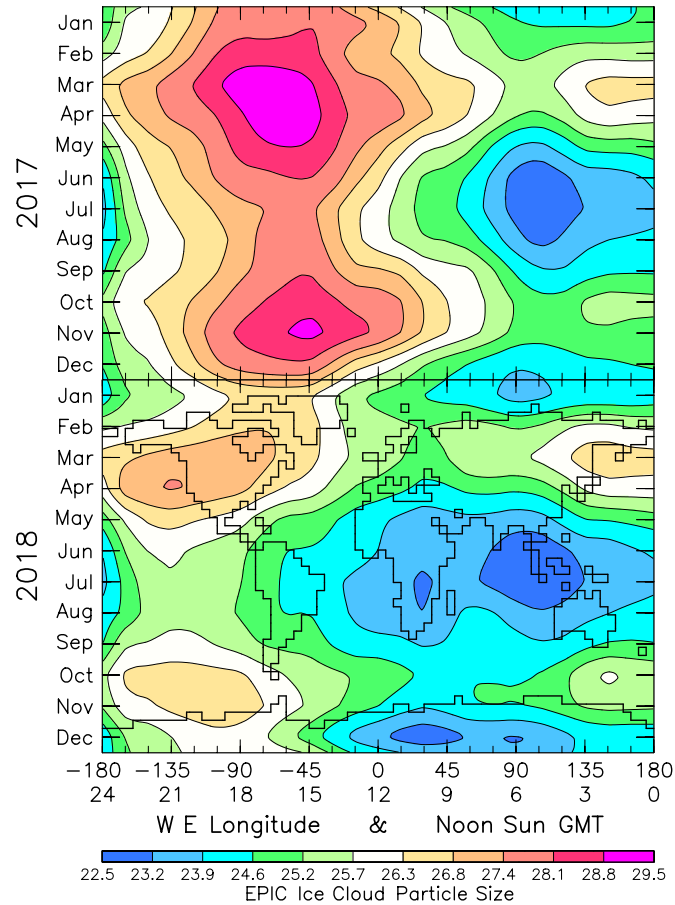
CERES-based Earth Energy Imbalance over Past Two Decades
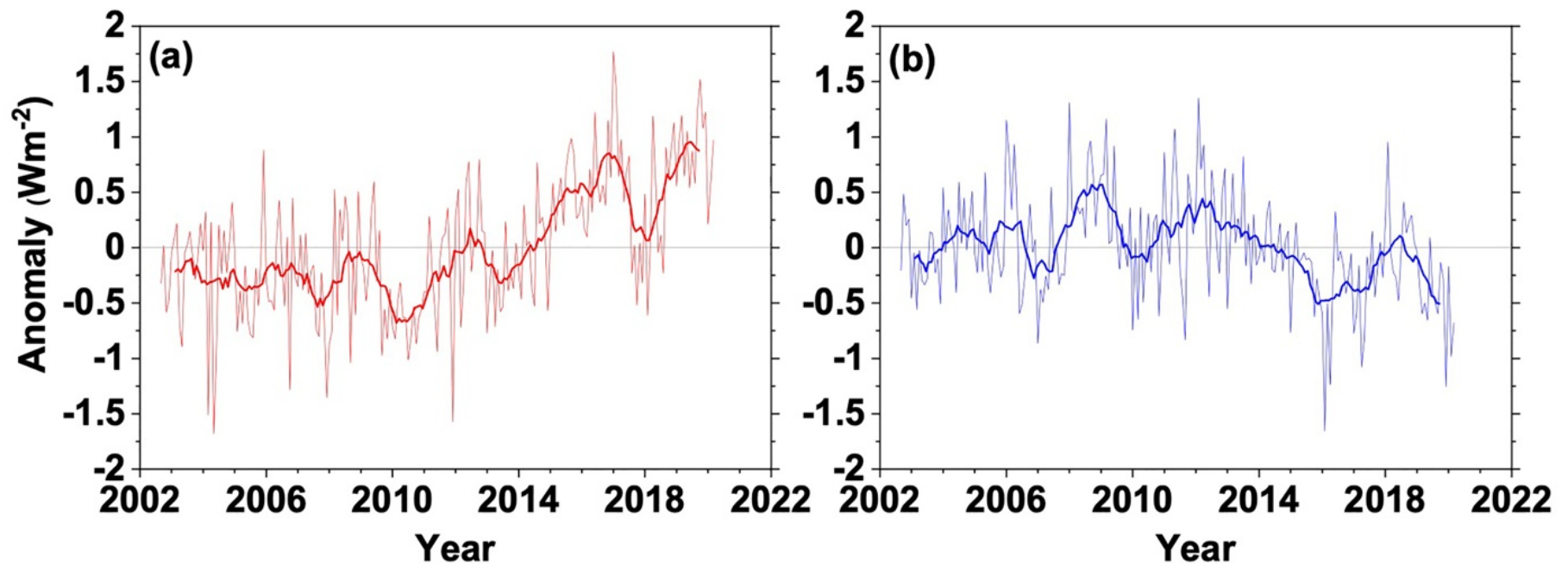
Figure 2. from Loeb et al. (2021). **(a)** Absorbed solar radiation. **(b)** Emitted thermal radiation. The results imply an increase in the reflected solar radiation by about 1.0 Wm^{-2} from year 2017 to 2018, and also an increase in outgoing thermal radiation by about 0.5 from year 2017 to 2018.

EPIC La Nina Activity Detection based on 2017-2018 Changes

1. Planetary Albedo: Short period (~month), relatively small-scale (30º, 3000 km) variability

Cloud Property Changes   *Global Annual-mean Changes*

2. Ice-cloud Sky Fraction: Ice-cloud fraction increases by: 4.76% from 0.210
3. Water-cloud Sky Fraction: Water-cloud fraction decreases by: 0.25% from 0.401
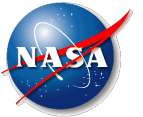4. Ice-cloud Altitude: Ice-cloud altitude increases by: 0.69% from 7.23 km
5. Water-cloud Altitude: Water-cloud altitude decreases by: 1.93% from 2.11 km
6. Ice-cloud Optical Depth: Ice-cloud COD decreases by: 7.56% from 4.84
7. Water-cloud Optical Depth: Water-cloud COD decreases by: 1.65% from 4.94
8. Ice-cloud Particle Size: Ice-particle size decreased by: 4.92% from 26.2 µm
9. Water-cloud Particle Size: Water-particle size decreased by: 4.42% from 15.8 µm

Closure Constraints
1. Reflected Solar Radiation: Reflected solar radiation increased by: ~1.0 Wm^{-2} (Loeb et al., 2021)
2. Emitted Thermal Radiation: Emitted thermal radiation increased by: ~0.5 Wm^{-2} (Loeb et al., 2021)

Sunlit Hemisphere Sampling (SHS) Simulator FORTRAN Code

TABLE 1.   Modeled on a 1x1 degree grid on a unit sphere, their (365-day annual mean) areas are:

	Latittude Zone:	SP	ST	NT	NP	SH	NH	EG
1	SUNdat Far-View	0.641444	0.918774	0.924059	0.657295	1.560218	1.581354	3.141573
2	SATdat Far-View	0.649225	0.917716	0.919639	0.654994	1.566940	1.574633	3.141573
3	SADdat Dst-View	0.644148	0.913867	0.915801	0.649901	1.558015	1.565702	3.123717
4	HEMdat Far-View	1.558963	1.568966	1.572627	1.582630	3.127929	3.155256	6.283185
5	EPIdat Far-View	1.566929	1.570507	1.571085	1.574663	3.137437	3.145749	6.283185
6	EPDdat Dst-View	1.558331	1.565808	1.566385	1.565856	3.124139	3.132242	6.256380
7	GCMdat Far-View	3.141593	3.141593	3.141593	3.141593	6.283185	6.283185	12.566371

Latitude Zones: SP=(S90-S30) ST=(S30-Eq) NT=(Eq-N30) NP=(N30-N90) SH=(S90-Eq) NH=(Eq-N90)

NISTAR-type Projected Area View: SUNdat is from L1 point, SATdat & SADdat are from Lissajous orbit

Flat Area View: (from L1 point): HEMdat views entire Sunlit Hemisphere only, GCMdat view is day & night
(from Lissajous orbit): EPIdat & EPDdat sample viewable fraction of Sunlit Hemisphere

Dst = Earth-Satellite distance dependent viewable fraction (2Pi for Far-View; less than 2Pi for finite distance)
(SHS FORTRAN code is available to interested DSCOVR Science Team members)

Conclusions

1. NASA's DSCOVR Mission *EPIC and NISTAR data provide new and unique diagnostic perspective* for assessing global climate model performance.

2. *NISTAR data are unique for NIR/SW spectral ratio diagnostic capability* to assess global climate model radiative transfer spectral treatment.

3. *EPIC climate-style planetary albedo diagnostics* show GISS ModelE2 overestimates clouds over oceans, underestimates clouds over land.

4. *EPIC Hovmoller maps provide La Nina activity detection* via planetary albedo space-time variability.

5. Zonal dependence can, *and should be*, implemented in longitudinal slicing.